

Harvest Incentives: A Tool for Managing Aquatic Invasive Species

Preface

Invasive species are estimated to cause the United States tens of billions of dollars in environmental and economic damage each year (Pimentel et al. 2005). Prevention, containment, and control of invasive species are necessary to protect native species and ecosystems, economic development in agriculture and industry, and animal and human health. Recently, there has been significant interest in managing invasive species populations by encouraging their harvest.

This briefing paper, adopted by the Invasive Species Advisory Committee (ISAC), a Federal Advisory Committee to the National Invasive Species Council (NISC), provides a framework for approaching harvest incentive programs for aquatic invasive species. The objectives of the paper are to:

- Discuss the biological, ecological, and socioeconomic considerations involved in programs that utilize harvest incentives to manage aquatic invasive species.
- Provide recommendations for consideration in the development, implementation, or support of incentive or harvest efforts that target aquatic invasive species.

For the purposes of this paper, the terms 'aquatic invasive species' and 'aquatic nuisance species' are considered equivalent; The later term is defined by the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 [PL 106-580 § 1003(1):]:

"Aquatic nuisance species (ANS) are nonindigenous species that threaten the diversity or abundance of native species, the ecological stability of infested waters, and/or any commercial, agricultural, aquacultural, or recreational activities dependent on such waters."

Background

Harvest incentive programs are generally defined as strategies that promote utilization of an organism for various purposes, including food, clothing, and biofuel. Recently, such strategies have been used to complement species or habitat management plans. Examples of programs that encourage harvest of invasive species with an associated incentive include:

- *Bounty Payments*— A program in which a predetermined amount of money is paid to an individual upon satisfactory evidence of collection of a specified organism.
- *Subsidy Payments*— A program in which production costs are reduced to improve success in bringing a product to market.
- *Contractor Payments*— A program that provides direct payment to a service provider to remove or harvest an invasive species.
- *Commercial Harvest*— An effort that is undertaken, usually privately, when a perceived market exists for an invasive species that can be harvested for sale in the free market.
- *Recreational Harvest*— Programs that allow recreational fishing, hunting, or trapping of invasive species by modifying seasons, license requirements, bag limits or other regulations.
- *Community Harvest*— Efforts by general public volunteers, lake stewards, interns, students, etc. to restore aquatic ecosystem quality and health

Before implementing a harvest incentive program, there must be a clear vision of the goal or outcome desired, a robust plan to achieve the goal, outreach that addresses stakeholders, program monitoring, and follow-up actions. It is critical to recognize that program goals will vary based on biological, ecological, and socioeconomic considerations. The specific objectives within harvest incentive programs will also vary and may include population control, engagement of the public, or increased awareness of impacts.

Incentivizing or encouraging harvest may not be the most effective method of control or may need to be employed in tandem with other efforts. Multiple strategies that employ adaptive management may be the most effective in achieving the identified goal for the target species. Consequently, careful analysis should be conducted to select methods that are cost-effective and both socially and legally acceptable. Once an incentive program is selected for implementation, outreach should communicate the impacts of the target species on the environment, economy and public health and why harvest is necessary. Finally, the development of an exit strategy is critical to help determine program termination or adaptation within the program. Identifying and utilizing measurements of program success will be a key component of the exit strategy.

Harvest incentive programs have demonstrated success in reaching program objectives of managing non-native or other undesirable species (e.g., Bomford and O'Brien 1995, Choquenot et al. 1998, Dedah et al. 2010). However, other studies have suggested that incentives to control species populations may be problematic (e.g., Hassall and Associates 1998, Bartel and Brunson 2003, Barbour et al. 2011). These latter studies have reported such programs as ineffective at reaching the intended management objective, damaging, costly, and producing a

poor return on investment compared to other available control measures. Until a thorough analysis is conducted, incentive programs that aim to manage aquatic invasive species should only be undertaken following careful consideration of the biological, ecological, and socioeconomic specifics of the targeted species. Furthermore, these programs should only be implemented if there is a strong commitment to accomplish measureable goals and objectives and effective methods have been identified that will ensure removal or long-term sustained reduction of the target species. Harvest incentives alone are generally not an option for eradication of aquatic invasive species as they typically cannot meet the generally accepted criteria for a successful eradication campaign (Bomford and O'Brien 1995).

Nutria Harvest -Two Approaches

Nutria have significantly invaded both Chesapeake Bay and Louisiana where different harvest strategies are being utilized. Chesapeake Bay officials decided to pursue eradication because the population size ($\pm 100,000$) was small enough to allow for eradication given available resources. Rather than encourage public harvest, the program began with a "knock-down" phase where high density populations could be found and traps, firearms, and dogs could be easily employed (Nutria Management Team 2012). As the population density decreased, the program put relatively more effort into deploying improved detection methods before they could use the standard removal techniques. Because bounties are illegal in Maryland, the program relies on wildlife specialists from the U.S. Department of Agriculture for continued harvest. In contrast, millions of nutria are thought to exist in Louisiana. As the Louisiana Department of Wildlife and Fisheries noted, "Currently in Louisiana, there is no known method that will completely eradicate nutria, nor is it a viable option." Instead of pursuing eradication, Louisiana's Coastwide Nutria Control Program consists of an economic incentive payment of \$5 per nutria tail delivered by registered participants to collection centers. The goal of the Program is to encourage the harvest of 400,000 nutria annually from coastal Louisiana (Hogue and Mouton 2012).

Biological Considerations

Invasive species exhibit distinct life history traits that enable them to thrive in new habitats and traditional species management principles may not be directly applicable to invasive species management. Consequently, understanding the population dynamics and life cycle of the species is the foundation for the successful management of invasive species (Barbour et al. 2011). Therefore, prior to implementing an incentive program, the population dynamics of the targeted species (e.g., density dependent processes, demographic structure) should be examined. However, limited biological information should not hinder management actions upon the target species. In circumstances where the target species may spread rapidly, undertaking control efforts despite limited understanding of the success of the outcome should proceed (Simberloff 2003).

Monitoring the population of the target organism is essential to determine the effectiveness of the program; ideally the target organism must be detectable at low densities and found relatively easily. If the target organism is cryptic, located in an isolated area, or inhospitable environment that cannot be easily accessed, the effort required to both monitor the population and the effort needed to remove individuals will be high. Consequently, monitoring will be an important component throughout the program implementation.

Ecological Considerations

The management of aquatic invasive species through harvest may cause potential damage to non-target species (e.g., by-catch, increased human activity, habitat or ecosystem damage). Given the complex interactions among species and their environment, it is often difficult to predict the outcome of the removal of invasive species. Therefore prior to initiating any harvest program, a careful evaluation of the functional roles of invasive species within the ecosystem and trophic interactions with native species is encouraged.

Biological invasion can result in the loss of biodiversity as well as an alteration of ecosystem processes. Therefore, the simple removal of the target species will likely require additional effort to restore the native community. For this reason, habitat restoration and long-term monitoring will be crucial components of the management effort.

A Multifaceted Approach to Species Management

Adoption of a harvest program is under review by the Asian Carp Regional Coordinating Committee. In a recent study, Garvey et al. (2012) identified a number of key issues if market approaches are to be utilized effectively including re-colonization potential during harvest, nutritional composition of fish, and how an incentives program might function.

The study noted that developing a diverse Asian carp market could be effective as a control activity. For example, efforts focusing solely on large fish may not deliver population control. Therefore all sizes of carp must be harvested and markets for multiple fish sizes must be developed to allow effective population control.

The study highlights the need to invest in baseline research to develop an effective strategy, as simply encouraging the public to "go forth and use" will almost certainly not achieve desired goals. However, combined with an understanding of the target species biology, harvest incentives may play an important role alongside other control measures.

Human Health Considerations

Incentive programs can involve members of the public who may be untrained in the proper methods of capturing and handling the target species. This lack of information can have serious consequences. For example, lionfish (*Pterois* spp.) tournaments have risen in popularity and serve as a means to raise awareness and manage localized populations of this invasive species (Morris 2012). However, improper handling of the fish can lead to significant injury if the venomous spines puncture skin and consumption may result in contraction of the tropical disease ciguatera. Even when harvested by professionals, there are concerns for encouraging the harvest of invasive species, as public health risks may result from handling, utilization, or consumption of the species. Before promoting harvest, the target species should be carefully evaluated for potential risks to human health.

Socioeconomic Considerations

Managers must consider various socioeconomic factors in choosing and designing an effective management strategy. Managers must weigh the social and political consequences of implementing, or not implementing, harvest incentives against the potential benefits and risks to the resource. The public's involvement in an incentive program will be motivated by a variety of biocentric and anthropocentric values (Jones et al. 2012), which will likely vary widely among individuals. Conflicts may arise from differing perceptions between resource managers who must consider all aspects of such programs and advocates for harvest incentives who may be more focused on the perceived benefits.

Market Economics and Unintended Outcomes

Using harvest incentives successfully will depend in part on the value of the harvested commodity, the cost associated with the harvest, and the minimum profit acceptable to the harvester. The marginal cost and effort needed to capture the target species is expected to increase as the population decreases. Thus, managers need to plan accordingly by either raising bounties (if used) or employing additional control mechanisms. In some cases the use of supplementary control and ecosystem restoration methods may enhance the effectiveness of the program; in others the concurrent use of control methods may reduce the economic viability of harvest programs. Careful planning can help anticipate and mitigate these issues.

Perhaps the biggest challenge to using incentivized harvest is its potential to generate unintended outcomes (i.e., perverse incentives) that could unintentionally cause the further spread or persistence of the target species. For example, people may come to rely on the income that harvest of the target species generates or may develop a preference for the species and value its long-term presence. These perverse incentives may encourage the intentional release of species back into the control area or into previously non-invaded areas, in order to promote the success of the introduced species (Lambertucci and Speziale 2011). Such activities have been observed as part of traditional restoration activities, where people have "seeded" favorite nonnative gamefish into areas that had been restored for native fishes. Additionally, individuals that perceive incentivized harvest as a benefit in one region may intentionally introduce the species into new regions. Anticipating the potential for possible unintended outcomes will be an essential exercise prior to implementing an incentive program.

Legal Issues

In choosing an effective management strategy, managers also need to consider existing federal, state, and local laws. Managing aquatic invasive species with the use of harvest incentives is complex when multiple jurisdictions are involved. Federal and state agencies often have differing policies or restrict certain harvest activities. For example, the 2013 *Python Challenge*, sponsored by the Florida Fish and Wildlife Conservation

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Commission and Everglades National Park, permitted hunting in Big Cypress National Preserve and state lands; however, hunting was prohibited in adjacent Everglades National Park. In order to ensure the greatest number of target species in a population can be removed, it may be necessary to use alternative control methods or introduce legislation to allow access to all lands.

Market demands may require a species to be supplied in a particular way, yet these requirements may not always comply with federal regulations. For example, certain markets may prefer live Asian carp, but their listing as injurious wildlife under Title 18 of the Lacey Act (18 U.S.C. 42) prohibits live interstate and cross-border movement. Specific legal constructs may not be able to accommodate market demands particularly when measures have been taken to minimize further introduction. Therefore, amending legislative and regulatory authorities may be required to create effective harvest incentive programs.

Outreach

Regardless of which mechanism is selected for control, strong public outreach is essential. When the public understands and accepts the need for control of a specific species then a successful incentivized harvest program can be realized (Hassall and Associates 1998, Dedah et al. 2010). Building support for an incentive program and encouraging active participation requires outreach that communicates the impacts of the target species on the environment, economy, and public health. Outreach programs may also generate financial support for the effort from decision-makers and ethical support from a community that may have disparate moral, emotional, or cultural views on killing the target species.

Stakeholder engagement can also help resolve possible differences prior to program implementation. For example, what is considered a pest by one person may be an essential income source to another and a source of recreational pleasure to a third. Outreach and facilitated discussions with the public can help resolve disputes before program implementation begins.

There may be situations when incentivized harvest is used to raise awareness of aquatic invasive species issues rather than providing for a level of species control. In these cases, the harvest activity becomes the vehicle through which a message is communicated. For example, the 2013 *Python Challenge* provided financial incentives for the harvest of non-native constrictor snakes in southern Florida. Although this effort resulted in few individuals removed from the population, the attendant media coverage provided significant outreach benefits by increasing awareness of invasive species and steps that public can take to mitigate impacts and prevent future invasions.

Conclusion

The success of any harvest incentive program to address aquatic invasive species will depend upon numerous biological, socioeconomic, and legal considerations. Programs that encourage harvest may be a successful management tool in targeting small, distinct populations in high priority areas within a larger invasion or they may play a supplementary role within larger control programs. Their use, however, will require careful review, planning, and monitoring to ensure success and that they do not unintentionally lead to further spread of invasive species, cause additional harm to native species, or waste valuable resources.

Recommendations

Incentivized harvest is just one type of strategy used to manage and control invasive species. As dedicated funding for invasive species management is limited, resource managers should conduct a basic analysis of various options based on the life history of the target species and relevant socioeconomic factors to identify

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the most effective solution. The anticipated costs and risks of eradication should be weighed against long-term control and management that mitigates damage to an acceptable level. ISAC recommends the following be considered before implementing any harvest incentive program:

1. Develop a management plan prior to undertaking a harvest incentive program. The plan should incorporate each of the following:
 - a. Program goals and measures of success - The goal of the program and the method used to measure completion of the goal should be clearly identified.
 - b. Cost analysis - Once the decision has been made to reduce numbers of a specific invasive species, then costs (both monetary and welfare) of various potential control methods should be compared to identify the most cost-effective method.
 - c. Target species' biology - Managers should gather the best available information about the species.
 - d. Address humane treatment - Processes for humane treatment of target species, including euthanasia, should be established.
 - e. Human and wildlife health risks - Before managers encourage harvest, they should ensure that the target species and the associated harvest activities do not pose a significant risk to human or wildlife health through any aspect of the harvest program.
 - f. Potential ecological outcomes - Species interactions and the effect of removing or reducing the target species from the ecosystem should be evaluated prior to program start.
 - g. Risk of creating perverse incentives - Before initializing a program, identify the possible perverse incentives that may exist and include a plan to address them.
2. Incorporate the following into the implementation of any harvest incentive program after the development of a management plan:
 - a. Monitor for unintended consequences - Incentive programs and commercialized harvest of invasive species may create perverse incentives that do little to encourage long-term control or eradication. The program should be adequately supervised to prevent such occurrences.
 - b. Monitor for ecological disturbances. - Project activities should be evaluated to reduce any potential disturbances to native populations or habitats.
 - c. Incorporate adaptive management - Harvest may be successful early on when there are large, easily accessible populations, but other control measures may be needed as species density declines or if methods are unsuccessful.
 - d. Encourage active enforcement to help mitigate perverse incentives by creating a dis-incentive to release the target species back into the control area or previously non-invaded areas.
3. Incorporate Outreach
 - a. All outreach should be clear about the goals of the program to encourage public and stakeholder support throughout the development, implementation and completion the program.
 - b. All outreach should help ensure that public does not grow to "desire" the targeted species. Success is more likely if the public understands the long-term harm the species can cause.
 - c. When outreach is the primary objective of a harvest program be sure to carefully plan for maximum media exposure.

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